

THE UNIVERSITY OF MICHIGAN

COLLEGE OF ENGINEERING
HIGH ALTITUDE ENGINEERING LABORATORY
DEPARTMENTS OF
AEROSPACE ENGINEERING
METEOROLOGY AND OCEANOGRAPHY

Quarterly Report

High Altitude Radiation Measurements

1 April 1968 - 30 June 1968

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Abstract

This report is a summary of project activities during the period 1 April 1968 to 30 June 1968. Preparations and tests for the next balloon flight and measurements of 15 μm CO_2 coefficients are described. Reports published are listed.

I. Introduction

This is the 22nd quarterly progress report on contract no. NASr-54(03), covering the period 1 April 1968 to 30 June, 1968. The project effort during this time was devoted to:

1. Modification of the U of M IRIS Interferometer
2. Preparations for the next balloon flight
3. Laboratory measurements of CO₂ transmission
4. Report Writing

II. U of M IRIS Interferometer

A. Modification of Viewing Scheme and Housekeeping Data

An external view mirror was designed and constructed to allow the U of M IRIS to view the horizon and at elevation angles of 22° and 44° above the horizon, as well as to look downward at the earth. The mirror view angle is changed by the motor driven mechanical arrangement shown in figure 1. The unit is mounted on the balloon gondola beneath the U of M IRIS. Its operation is synchronized to take place between interferometer scans so that there will be no electrical motor noise on the interferometer data.

The sequence of 16 interferograms which will make up one data cycle of the U of M interferometer has been changed slightly from the sequence initially planned and indicated in the last progress report. The sequence of interferograms will be:

- a) 4 of earth radiance
- b) 2 of cold black body
- c) 2 of the warm black body
- d) 2 of the horizon
- e) 2 at 22° above the horizon
- f) 2 at 44° above the horizon
- g) 2 of the mirror itself as a target

The mirror is used only for horizon and above horizon viewing. In these cases, corrections must be made for the mirror radiance.

The unit has been tested on the gondola during system checks, but has not yet been tested in an environmental test chamber.

The following voltages and temperatures have been added to the house-keeping data that will be monitored during the balloon flight;

- a) The U of M IRIS cold blackbody temperature
- b) The IRIS control unit +10V., - 10V., and -24V supplies

The same signals will be monitored in the interferometer ground test box, as will the following; the T.I. IRIS blackbody control, +15v., -15V., and +3V.

B. Programming of Data Analysis

A major effort has been expended in the development of programs (in spite of the complication of operating during the change over from IBM 7090 to IBM 360 system computers).

A basic outline of the data analysis scheme for one sided interferograms having -400 words and +2500 words of data is as follows:

1. Compute the spectrum using transform for two sided interferogram and ± 400 words.
2. Compute phase function, use sine and cosine components.
3. Compute convolution function, using phase information
4. Convolve phase function with interferogram to obtain phase corrected interferogram
5. Compute high resolution spectrum using +2500 words

The scheme works very well when applied to black body data. However in the case of sky radiance, phase shifts in the data are often difficult to understand. The analysis problem in this case has not yet been completely solved.

III Preparations for the Next Balloon Flight

A. Ozonesonde Test.

One engineer and one technician traveled to Essa, Boulder, Colorado for instructions in preparation, flying and analyzing data of the Carbon-iodine ozonesondes which will be used to provide background data for the balloon flight. Later, three ozonesondes were prepared for flight use. An ozonesonde was flown from the Flint, Michigan, ESSA Weather Bureau station on June 12. The vertical distribution of ozone obtained on this flight is shown in figure 2.

B. Filter-Wedge Cooling System.

During the environmental test which was carried out on 13 March 1968, the simulated filter wedge instrument temperature indicated that cooling would be required for the instrument during the balloon flight.

The liquid nitrogen cooling system for this purpose was constructed. It is designed to operate whenever the base plate of the filter wedge instrument is above 10°C and the gondola is above 25000 feet. The unit is shown in figure 3.

C. Miscellaneous Tasks

Following is a list of the numerous miscellaneous tasks carried out in preparation for the balloon flight.

1. Infrared Etachrome film for use in one of the 70mm Maurer cameras was tested for exposure information.
2. A second telemetry test flight unit was constructed and tested in vacuum.
3. A pre-flight check out test was compiled. Total pre-flight preparation time will be 4 hrs. 50 mins.
4. The MRIR instrument was tested by taking sky radiation measurements.
5. The baroswitch for the FAT boom motor was installed and tested.
6. Freezing time tests were run on the interferometer ice trays. After minor modifications in the freon refrigerator portable, it was found that both the ice trays could be frozen in about 2 hours if liquid nitrogen were used for cooling the alcohol in the refrigerator.
7. The Astrodata time code generator was cleaned, inspected and a burned out fan motor was replaced.
8. A new ink manifold for a defective Brush recorder arrived and was installed.
9. The remaining VCO's needed for the balloon flight were received and tested.
10. Additional Silvercells needed for increased gondola power requirements and for standby were ordered.
11. The MRIR solar calibrate mirror circuits were re-designed.

D. Gondola Testing

Modifications which were made after the 13 March environmental test were completed by the end of May. A new sequence of gondola tests started on 13 June.

Component tests were completed, the telemetry system was checked out and the first warm test (warm interferometer) was carried out on 24 June, with the following adverse results:

1. The linear actuator for the T.I. IRIS blackbody did not work properly.
2. The filter wedge door did not operate.
3. The PDP-8 computer in the bus (which analyses housekeeping data) broke down.
4. Several LR 15 silvercells became defective.

After correcting the above problems, a cold test was run in the afternoon of the same day. This test revealed that the linear actuator was still wired improperly. In addition the mirror drive of the U of M interferometer changed its speed as the instrument cooled. Two causes were found.

1. The telemetry R. F. signal effected the drive amplifier.
2. Moisture condensing in cable connectors of the interferometer produced an intermittent high resistance short circuit across the mirror drive feed back coil.

After these problems were corrected, more batteries failed and replacements were not yet obtained by the end of this work period.

E. Launchsite Inspection Trip.

A trip was made to the companies that bid on the balloon launch operations to help decide on a contractor for this purpose. Winzen Research was selected on the basis of their experienced launch crew. An extensive investigation of possible balloon launch sites was also made on this trip. Tentatively, the airport at Winner, South Dakota was selected for the balloon launch.

IV Laboratory Measurements of CO₂ Transmission (by Henry Reichle)

The Baratron pressure gauge was returned by the manufacturer during the early part of this period and data acquisition for CO₂ broadened by N₂, A, O₂ and H_e was begun. The work was slowed somewhat by a recurring problem of the presence of CO₂ in the gas that was used to purge the instrument. After several attempts to remove the CO₂ from high pressure air for use as a purge gas it was decided that Liquid Carbonic Hi Purity grade nitrogen would be used to purge the instrument. The use of nitrogen appears to have solved the purging problem (although this is at the expense of reduced source life).

Data have been obtained at several CO₂ partial pressures at path lengths of 8.75 cm. and 199 cm. On the basis of these results it appears that the band averaged broadening factors will be determined at a CO₂ pressure of 100 Torr. at 8.75 cm. and at 300 Torr and possibly 100 Torr at 100 cm.

The data from these runs were reduced using the mobile telemetry ground station (the data are recorded on magnetic tape in analogue from using IRIG channels 10 & 12) and PDP-8 computer. Computer programs for the data reduction and processing have been completed during this period. During the next period it is anticipated that the determination of the band averaged broadening factors for the various gasses will be completed and that the determination of the wavelength dependent broadening factors will be started.

V. Report Writing

Quarterly reports 05863-20-P for 1 October 1967 to 31 December 1967 and 05863-21P for 1 January to 31 March 1968 were written and distributed.

A lecture on "Interferometry" was given in a Short Summer Course on "Precision Radiometry by L. W. Chaney.

A proposal for continuation of this research work was written and submitted.

VI. Future Work

It is anticipated that with the delivery of the TI IRIS interferometer in July, that final preparations for the balloon flight and the balloon flight itself will be carried out during the next work period.

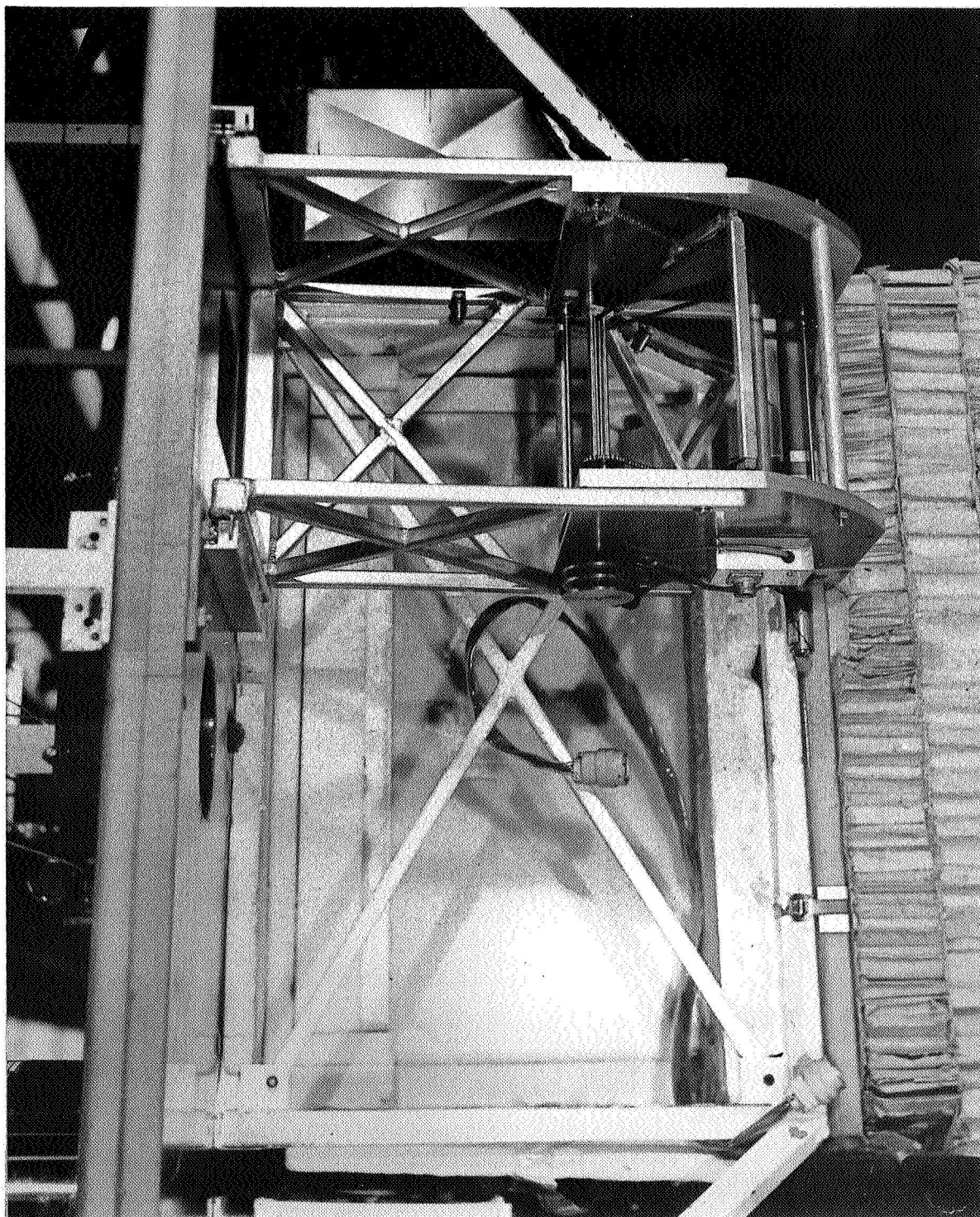


Figure 1. View Mirror for U M IRIS Interferometer

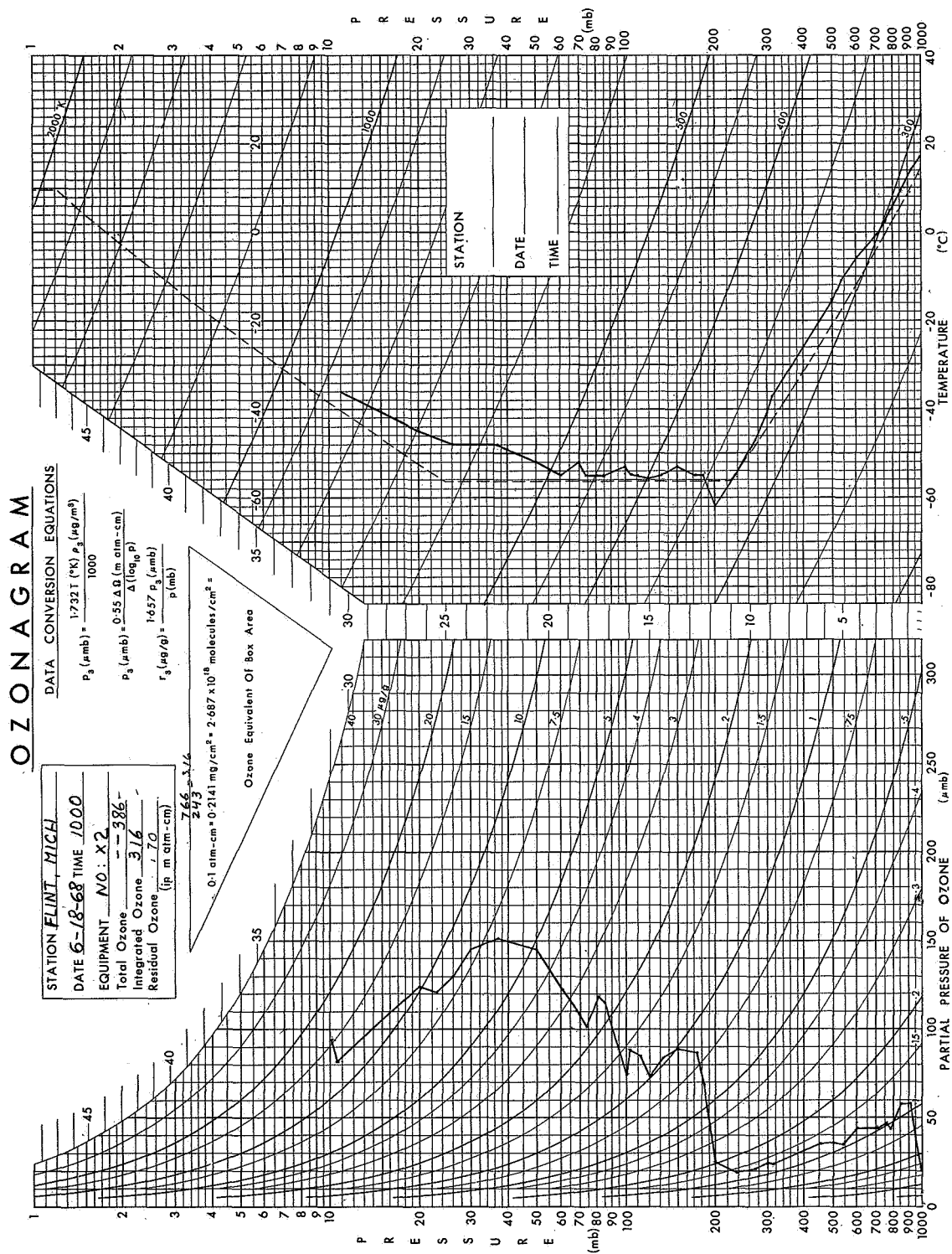


Figure 2. Ozone Distribution obtained on 12 June test flight at Flint, Michigan

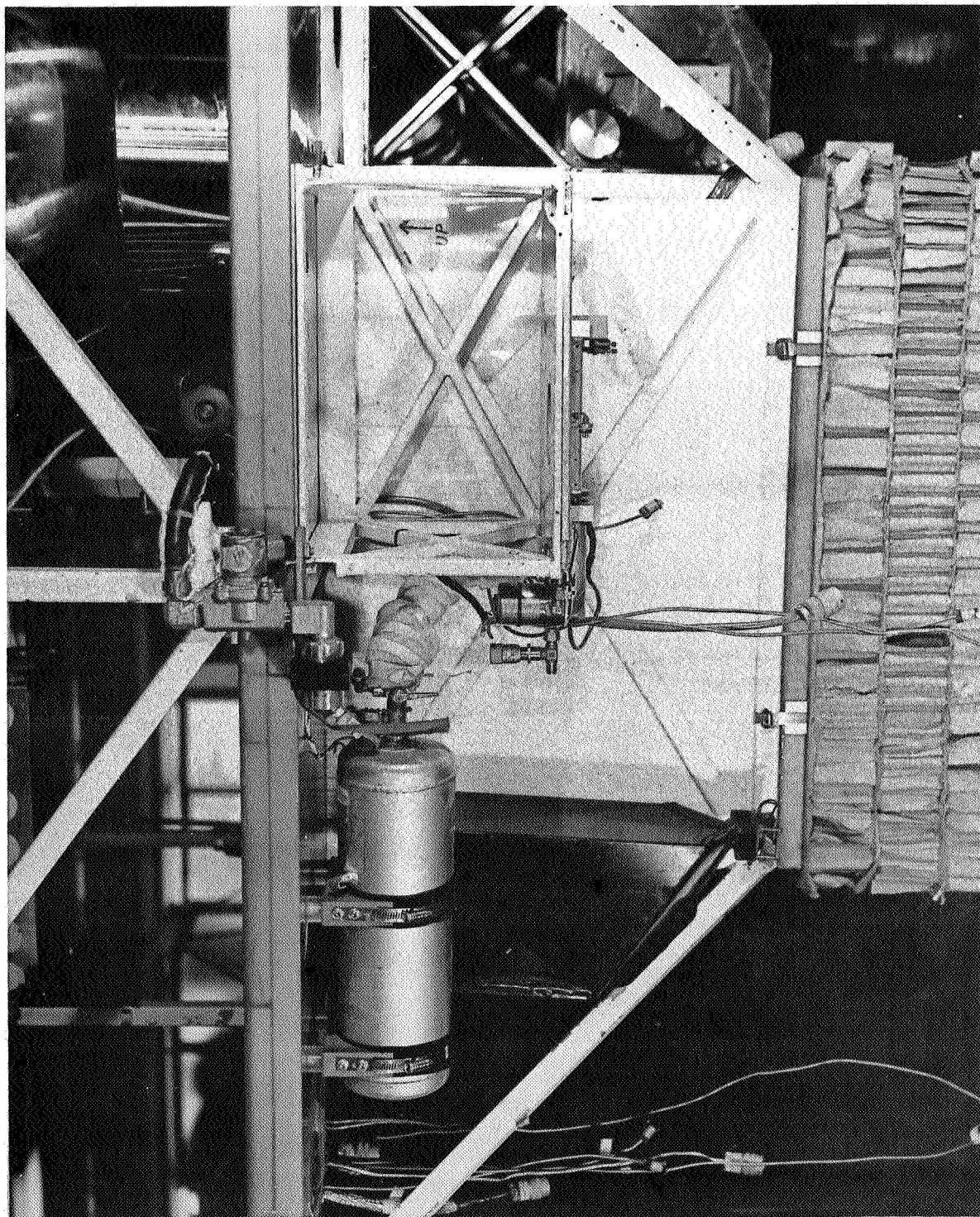


Figure 3. Filter-wedge Cooling System